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The Role of Competitive Forces in Integrated Resource Planning

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EXECUTIVE SUMMARY

In this report, we study the potential for competitive forces to enhance the efficiency of integrated resource planning and produce consumer cost reductions. We examine the efficiency gains from competition in the private power market, and ask whether similar forces can be successful on the demand-side of the market. The goal of this analysis is to identify and elucidate options available to state Public Utility Commissions (PUCs) to support competition in utility demand-side management programs to achieve efficiencies similar to those being achieved through development of competitive forces on the supply-side of the industry. We consider the entire market structure from upstream suppliers to distribution intermediaries to ultimate consumers. The market structure differs substantially between the demand-side and the supply-side of the electricity market. Demand-side electricity markets have a longer distribution chain and more intermediaries than the supply-side, which is attributable in part to the ultimately retail nature of demand and the wholesale nature of supply, and in part indicates market failures.

Sources of Efficiency Gains in the Private Power Generation Market

We identify four factors that produced cost efficiencies in the competitive wholesale market for privately-owned electricity generation. In all cases, the downstream supplier, i.e., the private developer, improved the efficiency of services delivered from upstream suppliers. These services include engineering, equipment, capital and fuel supply. First, standardization of power plant design has enabled some power developers to capture production economies. Second, technical innovations have been introduced by private suppliers. Long term fixed price contracts create opportunities to increase profit by lowering costs, and these can stimulate developers to innovate. Third, private producers have developed innovative financing strategies, which has expanded the scope of capital formation. Finally, project developers have formed strategic alliances which link downstream distribution with upstream supply in the private power market.

Competition and Market Failure for End-use Electricity Efficiency

We then illustrate how competitive forces are evolving in demand-side markets by focusing on two examples: the appliance manufacturing industry and the participation of energy service companies in demand-side bidding programs. First, in examining the structure of the appliance manufacturing industry, we find that the upstream suppliers of electricity-using devices (i.e. manufacturers) lack incentives to increase energy efficiency. The oligopsony power of large retailers limits the ability of appliance manufacturers to capture the profits from technology innovation. In addition, energy efficiency improvements often raise equipment costs, which can reduce manufacturer mark-ups by increasing price elasticity.

Second, we survey developments in demand-side bidding and the participation of energy service companies (ESCOs) to illustrate "downstream" institutions that have developed in the energy services market. DSM bidding programs involve customers or third parties competing for long-term contracts with utilities which specify amounts of *energy or capacity savings* to be achieved by a winning participant over a defined time period. We find that at the current stage of industry development, there is no a priori reason to believe that either ESCOs or utilities have a decided cost advantage for the delivery of energy efficiency. Measured data on the delivered costs per kWh saved over the long term are not particularly well documented for either ESCOs or utility DSM programs. Utilities have significant "incumbent" advantages (e.g., detailed knowledge of their service territory, long-term relationship with customers, and an established customer service infrastructure), lower costs of capital, and a greater ability to capitalize on economies of scale in terms of equipment costs (e.g., bulk purchase of efficiency equipment). Moreover, the utility, if it desires, has significant opportunities for cross-subsidization that can mask its true cost of delivering demand-side programs. In contrast, some ESCOs have demonstrated an ability to develop specialized expertise and skills in certain technologies or market segments. ESCOs also may have lower administrative or labor costs than a utility, which allow them to deliver DSM more effectively. Finally, ESCOs that participate in DSM bidding programs have an ongoing incentive to reduce costs and maintain and maximize savings, particularly if the ESCO receives fixed payments from the utility that are tied to verified performance over time.

Alternative Models for Injecting Competitive Forces into DSM Markets

We discuss four different ways in which the benefits of competition can be applied to demand-side markets. We characterize these options as (1) innovative approaches to integrate downstream (i.e., utilities) with upstream suppliers of energy efficiency products, (2) increased competition among energy service providers, (3) competition among the aggregation entities (utility vs. ESCOs), and (4) "yardstick" competition among utilities.

The first model involves efforts by utilities to stimulate the market for the next generation of high-efficiency equipment. This effort is currently focused on refrigerators. Compared to conventional utility refrigerator rebate programs, the so-called "golden carrot" incentive mechanism moves much farther upstream in an attempt to change the future efficiency mix of refrigerators produced. The approach reduces transaction costs by working directly with major manufacturers instead of thousands of appliance dealers/sales persons and millions of ultimate customers. Moreover, utilities can be confident that their incremental investments are pulling the market toward higher efficiency products that otherwise may not have been produced. Currently, utilities are concerned that customers would have purchased higher-efficiency units in the absence of utility programs. The "free rider" problem is minimized by this "market pull" strategy. Finally, these direct incentives to manufacturers might ultimately influence the market more effectively and at a much lower cost compared to conventional refrigerator rebate programs.

A second model involves expanded competition among third-party firms to encompass additional aspects of utility DSM program delivery. Expanded use of competitive processes by utilities to contract for DSM services represents a "middle" approach between DSM bidding and utility-sponsored DSM programs that rely only on in-house staff. For example, a utility will competitively select firms that can manage and deliver some or all services required by the DSM program for a turnkey fixed price. The utility may also negotiate some type of performance incentive with the contractor which is linked to achievement of program goals in addition to the firm's bid for services. Compared to DSM bidding, this approach maintains more control over program implementation, and effectively limits the nature and extent of contacts between customers and third party firms, who utilities perceive as potential competitors.

The third model is explicit or implicit competition between utility DSM programs and ESCOs. Competition between utilities and ESCOs may provide a market test that will serve as a benchmark to assess utility DSM performance in terms of program cost, cost-effectiveness, and development of DSM market potential. The Wisconsin Public Service Commission's order to Madison Gas & Electric (MGE) to conduct an Energy Conservation Competition pilot is probably the best example of an *explicit* competition between utilities and ESCOs. Structured competitions between utilities and ESCOs often will require PUC staff to assume a proactive stance and undertake very direct and sustained involvement in the implementation details of DSM programs. In most DSM bidding programs, competition between utilities and ESCOs is *implicit* in the sense that there is often substantial overlap between markets and end uses targeted by ESCOs and existing or proposed utility-sponsored DSM programs. ESCOs are concerned that they are competing against a moving target. Utilities can effectively undercut an ESCO's market opportunities by increasing financial incentives offered in utility-sponsored rebate programs. This makes it more difficult for the ESCO to achieve contractually specified demand or energy savings reductions. Implicit competition of this kind is typically counter-productive and inefficient.

The final model is "yardstick" competition among utilities in evaluating their DSM efforts. Using this approach, Commissions measure DSM program performance relative to some "yardstick," such as current practice or level of effort of other utilities in the state or region. Commissions set quantitative and qualitative DSM goals and expectations for individual utilities by translating the performance achievements of comparable utilities with the most aggressive programs after adjustments are made to account for size differences and unique conditions or circumstances. In practice, the value of and ease with which various "yardstick" indicators can be developed depends on circumstance. For example, the Wisconsin PSC regulates six small and medium-sized electric utilities. This situation is quite conducive to direct comparisons among utilities. Other commissions might only regulate one or two utilities of very different sizes and thus would have to draw on utilities from outside the state. The use of "yardstick" competition by regulators to compare utility DSM performance, while imperfect, is an area where we expect continued experimentation.

Conclusion

Competitive forces are developing and contributing to significant gains in efficiency on the supply-side. On the demand-side, the locus of decision-making in terms of defining demand-side resources is largely determined in an administrative fashion and represents the joint consensus of regulators, utilities, and other interested parties. Demand-side resource options are inherently diverse, diffuse, and decentralized, which, in fact, underlies the myriad market barriers that give rise to these efficiency opportunities. This diversity also leads us to conclude that it is highly unlikely that one type of competitive mechanism, such as bidding, will ultimately emerge as dominant. Rather, there are a variety of innovative and competitive mechanisms which deserve consideration and are likely to be promising in terms of improving the functioning of demand-side markets.

The models discussed in this study differ with respect to their underlying vision of the role of the utility in the demand-side arena. Approaches that involve "yardstick" competition among utilities, emphasis on increased competition among energy service providers for services defined by the utility buyer, and increased utility involvement with upstream suppliers tend to rely more heavily on the utility as the central agent in defining DSM resource opportunities. In contrast, in DSM bidding programs, third party firms that are relatively independent of utility control or guidance have a greater role in defining DSM resources and in providing comprehensive energy services.

The state utility regulator is ultimately faced with the responsibility for choosing what the emphasis of DSM activities will be in a particular region. Granting utilities an effective monopoly over DSM may potentially broaden delivery of programs, but raises cost control and subsidy issues. Competition can provide a check on utility costs, but it is not always feasible or effective. ESCOs are a limited substitute for utility DSM. Bidding by ESCOs for energy savings will provide some alternative measure of DSM costs, but many incommensurables, such as performance requirements, must be taken into account to make such comparisons. The model of regulation required to deal with the issues raised by integrated resource planning is active, because market forces, particularly on the demand side, are still weak.

1.0 Introduction

Two principal policy developments emerged in the electricity sector during the last decade: competition and integrated resource planning. Competition has appeared largely at the wholesale level between regulated and unregulated suppliers. Integrated resource (or least-cost) planning was initially a regulatory initiative aimed at assuring that utilities developed an appropriate balance between resources on the supply-side and the demand-side of the electricity market. These two policy developments, however, are in some sense contradictory. Competition is fundamentally de-centralizing, substituting market forces for the administrative determinations of regulatory bodies. Integrated resource planning, on the other hand, appears to expand the role of regulation in electricity by absorbing, to a considerable degree, the traditionally managerial role of resource planning and by promoting active intervention in end user markets. These conflicting trends have not clashed head on, because they largely appear directed toward different aspects of the electricity resource mix. Competition has been primarily concentrated on the supply-side, while integrated resource planning has focused mainly, but not exclusively, on demand-side activities as explicit resource options for utilities.

As integrated resource planning matures, however, there will be inevitable interactions between the competitive model and the administrative model. The most fundamental locus of this conflict is the resource allocation between supply-side and demand-side options. For a given level of incremental resources required by a utility, how much will come from supply-side options compared to demand-side programs? We can identify two conceptual models for answering this question. Integrated bidding programs including all potential resource options are one alternative for solving the allocation problem. Alternatively, an administrative solution is possible based on utility planning studies with regulatory approval. It is the thesis of this paper that neither of these models is fully adequate. We will focus considerable attention on the peculiar problems posed by demand-side programs that limit the all-sources bidding model as an efficient allocation procedure. The market failures associated with the demand-side, however, are not sufficient to reject the use of competitive processes in this sector entirely. The goal of this analysis is to examine ways in which competitive forces can be used in the integrated resource planning process to achieve, particularly on the demand-side, the efficiencies that are being realized through competition on the supply-side.

In this study, we examine the potential for competitive forces to enhance the efficiency of integrated resource planning and produce consumer cost reductions. This means both reducing the cost of DSM programs and ultimately improving the market for end-use efficiency investments. In Section 2, we characterize differences in market structure between the demand-side and the supply-side of the electricity market. We then review major factors that have contributed to the success of competitive forces on the supply-side in Section 3. Our goal is to ask whether and how such forces might be brought to bear on the demand-side. In section 4, we examine how competitive forces are evolving in demand-side markets by focusing on two examples. We discuss the structure of the appliance manufacturing industry, the countervailing market power of major retail buyers, and characterize the logic underlying appliance energy standards developed by the U.S. Department of Energy. We also survey developments in demand-side bidding and the participation of energy service companies (ESCOs) to illustrate "downstream" institutions that have developed in the energy services market. In Section 5, we examine four different ways in which the benefits of competition can be applied to DSM markets.

2.0 Comparing the Demand-Side with the Supply-Side of the Electricity Market: The Upstream/Downstream Distinction

We use the term market structure here to denote the chain of entities involved in the production, distribution, and consumption of the commodities used on each side of the electricity market. We use the term upstream to refer to actors (and activities) that are closer to production and downstream for actors (and activities) that are closer to distribution. These terms are often used in a relative sense, referring to directions, as well as in an absolute sense. This terminology originates in the petroleum industry. We extend its application here to electricity. Figure 1 is a schematic representation of these market structures that will be useful for our analysis. The demand-side market is comprised of millions of households, businesses, and industrial facilities that purchase electricity-using devices (e.g., motors, HVAC, and appliances) for the services they provide. Often these purchase decisions are not made by the ultimate customer, but by an upstream actor. The most prominent example is the case of new building construction, where builders/developers, working with architects and engineers, typically make the critical decisions, relying ultimately on equipment vendors. On the supply-side, the private power market involves developers proposing projects and securing power sales contracts from utility buyers. Private power developers depend upon their relationships with upstream suppliers of power generation equipment, fuel suppliers and investors.

Figure 1 illustrates two important aspects of the electricity market. First, the distribution chain on the demand-side is longer than on the supply-side. This difference is due in part to the difference between the ultimately retail nature of demand and the wholesale nature of supply. Second, there is no clear locus of exchange yet where the demand-side commodities can be traded-off against the supply-side commodities. A major focus of integrated resource planning is really designed to fill the institutional void where the two kinds of commodities, supply-side and demand-side, might in principle, be traded.

This "missing market" is due in part to the wholesale/retail distinction, but it is also due to the inherent measurement difficulties associated with demand-side commodities. If we want to trade-off supply-side products with demand-side products, we have a fundamental asymmetry with which to contend. While the supply-side commodities are more or less transparent, the electricity use aspect of demand-side commodities is bundled together with a host of other features. Consumers purchase electricity using devices for the services they provide. The focus

Figure 1. Market Structure

		Demand	Supply
Upstream	Production	Architects/Building Owners Appliance Manufacturers HVAC, Motor, Lighting Vendors	Power Generation Vendors Fuel Suppliers Lenders/Investors
↕	Distribution	Wholesale: Builders Dealers Trade Allies	Wholesale: Private Developer (QF or IPP)
Downstream		Retail: Utility DSM ESCO	
	Consumption	Ultimate Customer	Utility Buyer

of these purchasing decisions is typically on features other than the electric efficiency of the devices. Thus, refrigerators sell on the basis of their defrosting, ice-making and storage features, as well as size, shape, and color. The commodity ultimately purchased is a bundle of features. It is this bundling that makes for great difficulty in determining the electricity use effects of policy interventions in the demand-side of the electricity market. Separating the electricity effects from all other aspects of consumer behavior is a formidable task. While the electricity effects can be estimated, it takes substantial effort (see, in the case of appliance standards, U.S.Department of Energy, 1988).

The "missing market" can not be created by fiat. Even though, for example, the FERC's Notice of Proposed Rulemaking on bidding (FERC, 1988), envisioned a system of rules that would require supply-side bidders to compete with demand-side bidders, this has only occurred to a very limited extent. We discuss utility experience with integrated "all-source" bidding in some detail in Section 4.2. Integrated resource planning (IRP) can be thought of, in part, as a substitute for the missing market.

For now we call attention to two distinct intermediate entities in the demand-side market structure: utility demand-side management (DSM) programs and energy service companies (ESCOs). These entities represent a different way to aggregate retail demand-side actions to a level that is comparable with wholesale supplies. The activities of these intermediaries are designed to overcome perceived market barriers to DSM using various approaches to providing information, technical expertise, financing, and project management. The existence of these activities indicates the length of the distribution chain on the demand side of the market. To compare ESCOs adequately with utility DSM, we will address how they each connect with upstream suppliers in their market. The motive for this approach is the analogy with the supply-side of the electricity market. As the discussion in the next section will show, the interactions between the upstream and downstream segments on the supply-side have been productive and efficient, by and large. The goal of these comparisons is to provide perspective on the demand-side of the market, to judge whether and what kind of policy intervention could improve the effectiveness of competitive forces in that market.

3.0 Sources of Efficiency Gains in the Private Power Generation Market

Competition in the wholesale power market began with the passage and implementation of the Public Utility Regulatory Policies Act (PURPA). PURPA required utilities to purchase power from a new class of non-utility producers, Qualified Facilities (QFs).[1] Requiring utilities to purchase output from QFs created a new definition of the rights of utility competitors. QFs were exempt from state regulation, which meant that there were significant upside profit opportunities for private entrepreneurs. Finally, PURPA promoted non-utility ownership of QFs, because utilities could not own more than 49% interest in any QF. During the last decade, a new industry has been created. The private power market has substantially different characteristics from the regulated and vertically integrated firms that traditionally constructed power plants for electricity generation. In the early stages of development of the private power market, the consumer did not receive large direct benefits because of the avoided cost concept underlying PURPA. The price paid to private power developers was supposed to leave the consumer indifferent to utility or PURPA-based generation. This was the meaning and intention of the avoided cost concept. PURPA itself did not create a competitive market, but by creating a QF industry, it facilitated subsequent competitive developments.

Consumer cost reductions were eventually realized as the efficiency gains introduced by QF developers became reflected in prices. The primary mechanism for this process was the introduction of competitive bidding into the PURPA framework and the limited entry of independent power producers (IPPs), who did not have the legal right to avoided cost pricing. Bidding by private suppliers for long term contracts typically is based on some form of discount from the utility's avoided cost forecast. Winning bidders offer the largest discounts, ceteris paribus. Evidence reviewed in Kahn (1991) show price reductions on the order of 10% for both gas and coal-fired projects. Without real cost economies, of course, private suppliers should not be able to bid below avoided cost. For the purposes of this discussion, therefore, we will focus attention on the sources of these economies. We assume that competition, in keeping with recent

[1] Projects could obtain QF status by falling under a certain size limitation (initially 80 MW); cogenerators could be of any size, as long as they met minimum efficiency criteria.

practice, will pass most of these productivity gains along to consumers. Further discussion of competitive bidding can be found in Kahn, et al. (1989, 1990 and 1991).

The discussion in this section addresses four factors that contributed to cost efficiencies in electricity generation. In all cases, the downstream supplier, i.e., the private developer, improved the efficiency of services delivered from upstream suppliers. These services include engineering, equipment, capital and fuel supply. First, we discuss the standardization of power plant design. Several leading private power developers appear to have captured production economies associated with standardization. Second, we describe technical innovations introduced by private suppliers. Long term fixed price contracts create opportunities to increase profit by lowering costs, and these can stimulate developers to innovate. In a number of cases these opportunities were realized. Third, we describe the financial strategies used by private producers to lower cost. Because electricity is so capital intensive, financial innovation is an important contributor to cost reduction. Finally, we address the subject of strategic alliances. This is the most difficult factor to quantify, but it reflects various forms of integration between the downstream developers and upstream suppliers in the private power market.

3.1 Standardization of Designs

Baseload power plants constructed by regulated utilities during the 1970s were frequently custom designed. In the case of nuclear power plants, this phenomenon was largely a de facto product of rapid changes in regulatory requirements. For coal-fired plants, it was more commonly a choice made by the utilities to optimize fuel supply. Varying boiler designs were tailored to differences in coal quality. It might also be argued that this trend was consistent with assertions that regulation biases the firm's choice of technology toward more capital intensive alternatives (Averch and Johnson, 1962).

With the advent of the private power market, however, some developers began to pursue an explicit strategy based upon standardization of designs. The most well-known advocate of this approach, and perhaps its earliest proponent was Cogentrix Incorporated of Charlotte, North Carolina. According to a recent discussion of this firm's approach in the trade press, engineering costs amortized over multiple plants amount to only 2% of total cost compared to 8% for competitors (Hocker, 1990). An additional benefit of standardization has been an excellent record for operations and maintenance. Availability for plants constructed by Cogentrix has been consistently in the 95% range.

Other private power firms, such as Fluor/Daniel and NRG Energy, have also concentrated on standardization of power plant design. Fluor/Daniel has adopted a design of Duke Engineering and Services for a standardized coal plant. This design has been offered in joint proposals with Mission Energy, a subsidiary of Southern California Edison (SCE) Corporation. Two plants of this design were winning projects in Jersey Central Power and Light's 1989 RFP for new capacity and were awarded long-term contracts. NRG Energy, a subsidiary of Northern States Power (NSP), also offers a standardized coal plant design developed by its parent (NSP) in the unregulated private power market.

3.2 Technical Innovation

A number of studies have documented increases in the real cost of electric generating capacity since the 1960s (Wills, 1978; Joskow, 1987). Increasingly stringent environmental regulation has been cited as a major contributing factor in these cost increases. Pollution control devices for electric power were initially designed as "add-ons" that were not particularly well-integrated into the entire combustion process. Thus, flue-gas desulfurization (FGD), or "scrubbers," do not fundamentally alter the coal combustion process, but are just tacked on to the back end of conventional pulverized coal plants. Similarly, control of nitrogen oxides by means of selective catalytic reduction (SCR) is also a "back-end" device that meets local air quality standards. The cost range for FGD and SCR retrofits to existing plants is typically between $100-200/kW.

Newer electric generating technology achieves a better integration of the combustion and pollution control processes and provides one example of recent technical innovations on the supply-side. For gas-fired generation, where control of nitrogen oxides is of primary importance, steam-injected gas turbines (STIG) offer just such an advance. The STIG configuration involves a standard gas turbine and a heat recovery steam generator (HRSG). Steam from the HRSG is injected into the combustion turbine. This increases output and reduces nitrogen oxide production compared to simple cycle gas turbine operation. While SCR may still be required on STIG units, the capacity and cost of control in the STIG configuration is much lower than otherwise. Nevertheless, there seems to be considerable variation in cost estimates for STIG units. The EPRI estimate (JCPL and Sargent and Lundy, 1989) is nearly twice the cost reported by the first commercial STIG unit, a private producer at a California paper mill (Kolp and Moeller, 1989).

For coal-fired generation, where control of sulfur oxides is of primary concern, there are several new integrated combustion/pollution control technologies. Two that have been promoted by private producers are the circulating atmospheric fluidized bed boiler (AFB) and the integrated gasification combined cycle generator (IGCC). While both of these technologies have been deployed to some degree by regulated utilities, private power producers have developed the majority of AFB and IGCC projects.

The principal reason for greater technical innovation in the private power sector compared to the regulated sector is the greater opportunity for profit. Private producers develop projects under long term contracts that typically fix capacity payments at specified levels. These prices provide an incentive for cost reduction that is absent from rate-of-return regulation. The regulatory process usually passes all of the cost savings from innovation to consumers. Under competitive bidding, developers will retain some fraction of these gains for profit and pass some through in prices to obtain a competitive advantage.

Finally, some utility analysts argue that regulation of utilities has become hostile toward capital investment (Peck, 1983). Such disincentives create a particularly strong bias against technological risk. Principally as a result of disallowances associated with nuclear plant cost over-runs, some utilities perceive a high probability that costs incurred in risky projects that fail will not be recovered. This can make utilities risk-averse compared to private developers who have the opportunity for upside gain and are more willing to invest in innovative options with higher risk.

3.3 Finance

Private power projects are typically structured on a "stand-alone" financial basis, as opposed to the corporate balance sheet financing typically used by regulated utilities. The "stand-alone" structure is referred to as project finance. While there are many advantages to project financing, it also imposes constraints. Project finance commonly involves greater leverage than what is standard for regulated utilities. The percentage of total capital that represents common equity is usually above 40% for the utility company, and between 15% and 25% for the project financed power development.

At first glance, this greater leverage might give a cost of capital advantage to the private power project because debt costs less than equity. However, there are several offsetting factors. Regulated utilities with good bond ratings can probably borrow at lower interest rates and certainly for longer terms than most private power producers. High grade utility bonds commonly have thirty year maturities, while the loan terms associated with project finance seldom exceed twelve years. Furthermore, the cost of equity capital may be somewhat lower for utilities than for private power projects. Thus the overall cost of capital may not be lower for project finance compared to regulated utilities.

Nevertheless, project finance is an important innovation in the electricity industry because it provides an alternative mechanism for capital formation. New and successful mechanisms to attract capital are constructive contributions, because capital intensity is high in this industry. It is clear that private power can attract significant amounts of capital. According to reports in the trade literature, over $7 billion was invested in this sector in 1989, up from $5 billion in 1988 (Marier, 1990). The variety of financial arrangements available for these projects is also large. Private power projects have developed financial linkages between equipment vendors and associated credit institutions. For example, both Westinghouse and General Electric have credit subsidiaries that are active in the private power market. In other cases, project finance has made capital attraction easier than corporate balance sheet financing. Competition is now strong among credit suppliers to finance private power projects because the industry is well established.

Project financing is supported by the long-term contract between the utility and the private supplier. Such arrangements are not available to utilities under standard rate-of-return regulation because such regulation is essentially an implicit rather than an explicit contract. Although there may be no cost advantage for either mechanism, the existence of alternative structures is still useful. Project finance is an enabling mechanism that helps attract capital for private producers. By providing an alternative that facilitate competition, project finance is constructive.

3.4 Strategic Alliances

Private power developers must negotiate arrangements with a wide variety of firms both "upstream" in the factor supply markets, and "downstream" in the user markets. It is becoming increasingly common for developers to form strategic alliances with other firms as a way of lowering costs or sharing risks. In this section we provide examples of some of these relationships and describe their potential benefits.

Integration of fuel suppliers with particular development projects or developers is one important area where alliances are important. For gas-fired projects, it is difficult to obtain long-term fuel supplies at anything other than prices indexed to external market levels. To assure long term supply and some certainty over price, several developers have purchased gas reserves for some portion of their requirements. Costs of gas reserves are capitalized into total project costs and must be financed along with construction costs. While this may raise debt service requirements in the short-run, it can lower long run fuel costs and reduce the risk of fuel supply interruptions. A project initiated by Cogen Technologies in Linden, New Jersey, provides an example where these arrangements have been put in place. This 600 MW cogeneration facility has acquired gas reserves valued at more than $100 million. The New York Public Service Commission estimates that this project will save about 8% compared to the utility's avoided cost (NYPSC, 1989).

Integration of fuel supply also occurs with coal-fired projects. The Vista and Paulsboro projects in Logan, New Jersey are sponsored by a joint venture of Mission Energy, a subsidiary of SCE Corp, and Fluor/Daniel, a subsidiary of Fluor Corporation. Massey Coal, also a subsidiary of Fluor Corporation, will supply the fuel for these units.

Another area where the development function is integrated with "upstream" suppliers involves proprietary technology. While it is difficult in practice to define "new" technology unambiguously, in many cases it can be recognized when observed. We give three examples of this type of "vertical integration" in which equipment manufacturers/suppliers have become developers. Luz International, a vendor of a combination gas and solar electric generating system, has developed a number of projects operating in Southern California. No other firm develops projects using the Luz technology, so this firm has at least a short-run monopoly on its technology. By assuming the developer role, including the important negotiations with utilities and regulators, Luz is able to commercialize its technical innovation. Texaco Syngas, a subsidiary of Texaco, also markets a proprietary technology in this case involving coal gasification. Texaco is co-sponsoring a large project in Freetown, Massachusetts, along with General Electric and Commonwealth Electric. In this situation, the proprietary technology represents a part of the venture, but not the entire sponsorship, as with Luz. Dow Chemical's Destec subsidiary also engages in joint venture development of coal gasification technology. Pyropower, a subsidiary of the Finnish firm Ahlstrom, has taken a third approach. Pyropower is one of a number of vendors that sell AFB technology. In some private power projects, Pyropower has been involved as a limited equity participant, although in other projects, the company's involvement has been confined to the more traditional role of "arms length" equipment vendor. Pyropower's limited equity position represents a more limited sponsorship role than in the Texaco Syngas case, but does represent a certain degree of integration.

To summarize, in analyzing the private power market, we find that strategic alliances have facilitated the realization of benefits from technology innovation, while standardization of design and new methods to attract capital have improved the functioning of this market. By forging creative linkages among suppliers of generation equipment, fuel, and capital, private developers have created productive efficiencies that result ultimately in lower consumer costs. Having argued the case that competitive forces are functioning reasonably well on the supply-side, we now turn to an analysis of the demand-side of the electricity market. We attempt to pose the same kinds of questions, formulating them with regard to the special nature of end-use markets.

4.0 Competition and Market Failure for End-Use Electricity Efficiency

There is a widespread, but not universal, perception that the market for end-use electricity efficiency investments functions poorly. Proponents of this view argue that a powerful array of market barriers prevents customers from undertaking the full range of cost-effective investments in energy efficiency and thus direct involvement and investment by utilities is required to capture cost-effective DSM resources (NARUC 1988). Various kinds of evidence are typically cited to back up these claims of market failures in end-use efficiency investments. For example, several studies have attempted to show that the market acts as if the discount rate implicitly applied to energy efficiency investments is substantially higher than any reasonable estimate of the actual cost of capital.

The implicit discount rate measures how capital costs of high efficiency devices are traded off against the value of energy savings. In one version of this calculation it is the behavior of the market as a whole that is being measured (Ruderman, Levine and McMahon, 1987). This is an aggregate of decisions made through the whole market structure; decisions by manufacturers about what devices to produce, decisions by retailers and wholesalers about what products to distribute, and decisions by consumers about what purchases to make. Thus, distortions in the market show up as differences between real interest rates and the rate at which the market in aggregate is discounting efficiency. Other uses of the implicit discount rate concept have focused more narrowly on consumer behavior alone (Cambridge Systematics, 1988). The same qualitative conclusion emerges from these studies; namely the market for energy efficiency discounts at a much higher rate than normal interest rates. This means that the market is working imperfectly.

Evidence of market failure is one rationale for interventionist action. The promulgation of federal appliance efficiency standards is one response to this problem while utility demand-side programs represent another kind of response. In this section we examine two distinct channels through which competition operates on the demand-side of the electricity market: (1) the manufacture of home appliances, and (2) the emergence of demand-side bidding programs.

4.1 The Appliance Manufacturing Market

The appliance manufacturing market has been analyzed in connection with the federal program mandating energy conservation standards for home appliances. In this discussion, we rely primarily on the analysis of Stoft, Chan and Hobart (1990). They begin from the empirical observation that concentration in this market is high; the top four firms, for example, have about 95% of the market for refrigerators and freezers. While this degree of market concentration can be conducive to technological innovation, it may happen that innovation proceeds, but seller market power limits the benefits to producer profits, and also does not lead to consumer cost reductions (Stoneman, 1987).

There is a countervailing force, however, in the appliance manufacturing and distribution market, namely heavy concentration at the intermediate demand level due to the presence of large retailers. These large retailers, such as Sears, Montgomery Ward and Circuit City, have a substantial amount of buyer market power (AHAM, 1989). One reflection of this buyer power is that standard economic theories of supplier oligopoly do not appear to be substantiated empirically. In the Cournot oligopoly model, a high degree of supplier concentration is reflected in large price mark-ups above marginal cost. Mark-ups that are observed in the appliance manufacturing market are considerably lower than what empirical concentration ratios and the Cournot theory would predict. Stoft, Chan and Hobart argue that the buyer market power of the large retailers is what lowers mark-ups from the theoretical level. Thus they calculate an "effective" number of firms in the industry, which is much higher than the observed number.

The importance of these observations is that buyer market power raises the supplier firm's elasticity and therefore lowers profits (i.e., mark-up). Stoft, Chan and Hobart then go on to show that similar effects can result from improved energy efficiency. The key assumption in this next argument is that appliance demand has constant "life-cycle cost" elasticity. Life-cycle cost includes both original purchase price and operating cost. Any efficiency improvement will shift the elasticity away from the operating cost term to the purchase price term. Price elasticity increases as purchase price goes up and as energy cost goes down. Thus, the imposition of appliance standards will lower manufacturer's mark-ups because the manufacturer incurs additional costs in order to reduce energy use. The empirical specification of the manufacturer's impact model for the case of refrigerator standards does show this effect, although the magnitude is generally modest.

This argument is relevant to the entire spectrum of energy efficiency opportunities and makes some general predictions about them. The magnitude of the oligopoly innovation deterrence effect depends critically on the split in life-cycle cost between capital and operating cost. The refrigerator example is one in which the predominant term in life-cycle cost is capital. A typical retail purchase price for refrigerators is about $500 and annual operating costs are about $100. We assume that consumer discount rates are high; Stoft, Chan and Hobart use 200%. This means the life-cycle cost in the refrigerator case is about $550; and roughly 90% of that is capital. Even the most extreme refrigerator standard studied by DOE would only increase purchase price by 25% and lower operating cost by 50%. In this kind of case, the shift in the two components of industry price elasticity toward the capital side would be small. For other energy consuming products, the opposite would be the case.

Lighting represents a polar opposite case. For both incandescent and fluorescent bulbs, the life-cycle cost is predominantly operating cost. A 100 watt incandescent bulb lasting 750 hours costs approximately $1 at retail and has an operating cost of $7.50. Similarly, a 40 watt fluorescent tube, typically bought in bulk for about $1, has a lifetime of about 3 years at 3000 hours per year. The annual operating cost would be about $12. In these cases, major efficiency improvements can involve considerable shifts in the components of cost. The compact fluorescent (CFL) bulb, which substitutes for incandescents in residential applications, is an illustrative example. Typical retail cost of the CFL is about $20. It lasts 10-12 times longer than an incandescent and uses 25% of the power. Cost shifts of this magnitude and nature would increase manufacturing price elasticity and therefore put downward pressure on mark-ups. It could be expected therefore that manufacturers would resist this kind of innovation. In the case of CFLs, their recent growth in market share has come largely through the exogenous force of utility DSM programs which have targeted this device and often financed purchase price in whole or in part.

To summarize this discussion, we find that the upstream suppliers of electricity using devices face dis-incentives to increase energy efficiency. From an institutional perspective, the oligopsony power of large retailers limits the ability of manufacturers to capture the profits of innovation. The pressure from powerful downstream market forces can, under certain circumstances, improve the prospects for innovation, but there is no reason to believe that the large retailers exercise pressure of that kind. Second, energy efficiency improvements can reduce manufacturers mark-ups by increasing price elasticity. This seems particularly true for improvements that will shift a large fraction of life-cycle cost from operating expense to equipment price.

4.2 Demand-Side Bidding Programs

In this section, we examine "downstream" intermediary institutions that have developed in the energy services market and assess their ability to mobilize competitive forces in a productive fashion. Our discussion focuses on the energy service company (ESCO), the newest institution designed to improve the efficiency of the distribution chain. Energy service companies are firms that provide technical services for the energy management of a building or industrial process and provide financing for those energy management investments (Brown 1990).[2] ESCOs often use performance contracting to reduce barriers related to customers' perceived risks associated with efficiency investments as well as barriers related to a customer's lack of access to capital and information. Performance contracting arrangements can involve repayment of the ESCO investment from the actual bill savings, which minimizes or eliminates initial customer cash outlays.[3] In assessing ESCO capabilities and performance, we draw principally from their activities and participation in utility demand-side bidding programs. In these programs, there is another performance contract between the utility and the ESCO. This network of relations is illustrated in Figure 2.

4.2.1 Characterization of DSM Bidding

Competitive bidding for demand-side resources represents a parallel development to the competitive processes on the supply-side that were reviewed in Section 3. Proponents of "all-source" bidding argue that for the purpose of meeting new system demand, a kWh saved by efficiency improvements is indistinguishable from a kWh delivered to customers by a new plant (Cavanagh 1988). However, more careful examination of DSM procurements reveals that the parallels are limited and important differences between the two competitive arenas must be noted. The discussion which follows is based largely on Goldman and Wolcott (1990), Goldman and Busch (1991), and Chernick and Plunkett (1991).

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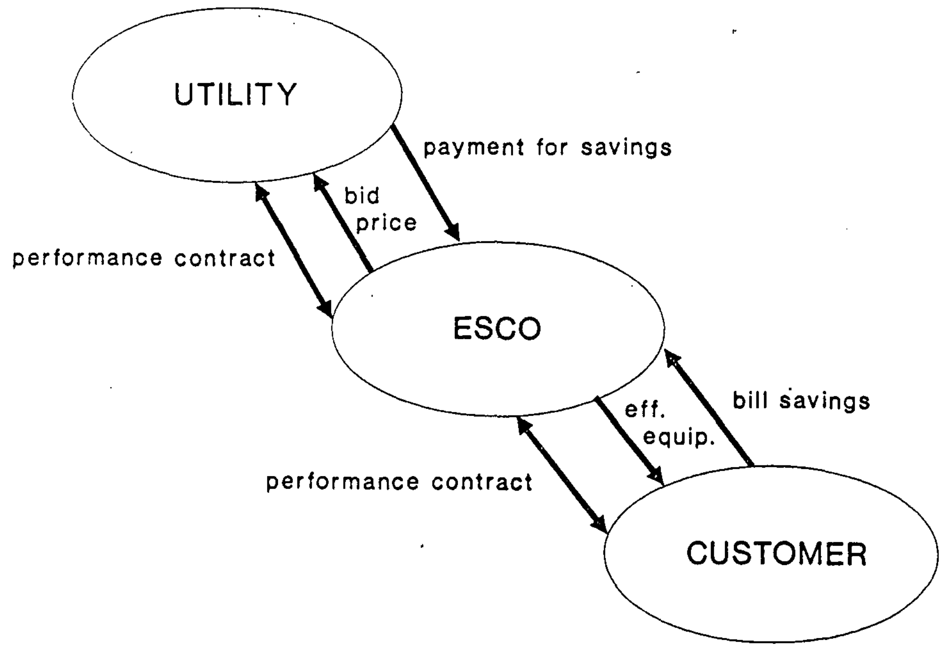
[2] These services include an engineering analysis of a customer's facility, installation and construction management of energy efficiency improvements, long-term operation and maintenance of the installed equipment, and financing for the whole enterprise.

[3] Often, performance contracts specify what happens in the event that savings do not occur, such as the ESCO providing best efforts to bring savings up to a minimum guarantee.

Figure 2. Arrangements between Utility, ESCO, and Customer



First, the market for energy efficiency is ultimately a retail market, while the competition for private power contracts is a wholesale market. DSM bidding programs involve customers or third parties competing for long-term contracts with utilities which specify amounts of *DSM savings* to be achieved by a winning participant over a defined time period. In principle, end-use customers can participate, but experience to date shows that direct customer involvement in demand-side bidding has been limited to only a few, very large customers. Instead, the major participants have been ESCOs. ESCOs perform an aggregation function that transforms individual demand-side resource opportunities into a product that more closely resembles wholesale supply-side resources. The existence of ESCO intermediaries is more evidence on the poor functioning of the market for energy efficiency.

Second, in addition to satisfying utility system needs, DSM projects proposed in a bidding program also are viewed by the utility in the context of their impact on customer service and satisfaction. Projects proposed by ESCOs typically include various types of measures that are installed at many individual customer facilities; success hinges on marketing and customer acceptance. ESCOs make DSM projects attractive to customers by providing use of the efficient equipment, typically with no out of pocket cash outlay. The cost of this equipment to customers is bundled into the ESCOs bid price to the utility which is paying for the performance of the project. These projects typically involve a three-way relationship among the host customer, ESCO, and utility, one which is new to most utilities and potentially threatening in some cases. Evaluating the economics of ESCO bids relative to supply-side projects is tricky because customer costs also must be included, although it is difficult for the ESCO to predict in advance each customer's financial contribution.[4] These uncertainties are due both to imprecision concerning consumer motivation and uncertainty about the mix of technologies that will ultimately be adopted.

Third, there are substantial differences in the measurability of output between the demand-side and the supply-side resources. The output of supply-side projects can be directly measured and utility managers are relatively confident that the supply-side project's interaction with the utility system can be predicted and managed. In contrast, demand-side bidding raises the fundamental problem associated with all policies directed at end-use efficiency, the problem of measurement. There are two aspects to the measurement problem: (1) does the installed equipment work as expected, produce the predicted savings, and last as long as anticipated, and (2) what would the end-use demand behavior have been in the absence of the policy intervention. From a utility resource planning perspective, it is necessary to address both questions to take credit for the system benefits of DSM programs.

These two problems are separated to some degree in the context of ESCOs participating in DSM bidding programs. The first problem, new equipment performance, involves verification issues between the ESCO and the utility. To receive utility payments for its activities, ESCOs develop a measurement/verification plan which must demonstrate that they have met their obligation to install and maintain the devices for which they are being paid. Payments to ESCOs are often linked to actual reductions in utility bills or metered savings over time from the device. In principle, the performance-based approach is one of the more attractive features of DSM bidding programs as distinct from typical utility DSM programs. It is also part of the agreement between ESCOs and customers over sharing the savings associated with the new equipment. The shared savings agreement implicitly addresses the second issue by focusing on the customer's baseline consumption pattern in the absence of the efficiency investment. However, a simple pre/post comparison of energy usage does not fully address the issue of predicting the customer's long-term investment behavior in the absence of the ESCO's project. Changes in activity levels, among other things, can affect savings estimates substantially. Also, over time, consumers may decide to make their own conservation investments without intervention by third parties, and thus "free riders" are not addressed by billing analysis of customer facilities. Thus, some utilities are also conducting impact evaluations of their DSM bidding programs which employ more rigorous experimental designs (e.g., time-series energy data for test and control groups) in an attempt to infer customer decision making.

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[4] Often, contributions from the customer pay principally for capital improvements and maintenance/reliability savings.

Table 1. Supply and DSM Resources in Utility Bidding Programs

Utility	RFP Issued	Amount Requested (MW)	Supply Projects Proposed (MW)	Supply Projects Winning (MW)	DSM Projects Proposed (MW)	DSM Projects Winning (MW)	C&LM Program Goal
Integrated Auctions							
CMP #1	12/87	100	666	0	36	17	≈65-105
CMP #2	5/89	150-300	2338	50	30	9	≈65-105
ORU	6/89	100-150	1395	181	29	18	≈76
PSE&G	8/89	200	654	210	47	47	≈360
JCP&L	8/89	270	712	235	56	26	≈200
Puget	6/89	100	1251	127	28	10	≈100
PSI Energy	12/88	550	1800	640	78	10	≈75
Niagara Mohawk	11/89	350	7115	405	162	36	≈350
Con Ed	2/90	200	2976	204	11.9	10.5	≈650
Separate Auctions							
LILCO	11/89	15-20	1750	132	23	10	≈350
Performance Contracts							
NEES - Supply	9/87	200	4279	204			
NEES - DSM					NP	13.6	≈326
BECO - Supply	5/88	200	2800	200			
BECO - DSM					NP	35	≈170

Notes: NP = Not Applicable

Fourth, the energy service industry is an "infant" industry compared to the private power market. For example, surveys of demand-side bidding reveal that it is a substantially smaller phenomenon, by virtually any measure, than competitive bidding on the supply-side. Goldman and Busch (1991) identify eight utilities that have conducted an integrated auction involving both supply- and demand-side resources. In these solicitations, DSM bidders have offered about 480 MW of demand reductions, while supply-side bidders have proposed about 18,900 MW of new capacity (Table 1).[5] A recent survey of 41 utilities found that over 8000 MW of supply-side projects have been selected in competitive resource procurements (*Current Competition*, 1990). Thus, because the energy service industry is relatively immature and DSM bidding is a new phenomenon, it will be difficult in principle to identify potential sources of efficiency gains that could be obtained by ESCOs compared to other utility-sponsored DSM programs.

With these caveats, we offer some preliminary observations on the applicability of the four factors that have contributed to cost efficiencies achieved by private power producers (see section 3) to third-party energy service firms in the DSM bidding arena. These comparisons illustrate some of the differences between demand-side and supply-side bidding.

4.2.2 Sources of Efficiency Gains

Standardization of designs is not as relevant for DSM bidding, in part, because the technical complexity of demand-side equipment is relatively low in comparison to power generating plants. ESCOs rely principally on off-the-shelf equipment, and thus, standardization of design has, in effect, already occurred. However, there is substantial technical sophistication required in the diagnosis and application of some end use efficiency technologies, particularly in the large commercial/industrial markets. The most successful ESCOs have developed standardized procedures to deliver various efficiency options and technologies. Moreover, installation of various efficiency options by ESCOs will always vary by site, because of the inherent nature of the ESCO/customer interaction and business relationship (e.g., customer has ultimate control).

Technological innovation is also not as yet much of a factor in the demand-side bidding arena. In part, this has occurred because eligible DSM measures have been restricted to proven technologies by risk-averse utilities in their DSM bidding programs.[6] Moreover, for ESCOs, the incentives run counter to innovation because they are at risk for operational failures, without much of a corresponding reward for success. At this point, innovation on the demand-side can be defined more by the effort to develop successful marketing and program delivery strategies

[5] Some ESCOs maintain that the level of awards for DSM bidders is more related to the high transaction costs of participating in bidding programs and the terms of utility procurements rather than evidence of industry immaturity.

[6] In some cases, DSM measures must belong to a predefined group of measure types (e.g., only load-shifting measures).

for various types of customers that will overcome perceived barriers to end-use efficiency investments. For example, some ESCOs specialize in working with niche markets (e.g., institutional customers and buildings) while other companies focus on the provision of comprehensive energy management services (e.g., audit, retrofit specification and project management, installation, guaranteed savings, financing, and O&M) as the vehicle to overcome market barriers. In any event, it is relatively easy for other parties, such as utilities and other energy service firms, to adopt these marketing and program design innovations. Thus, it will be quite difficult to protect a competitive advantage and competitive edges might be short-lived.

Project finance and access to capital are critical factors for energy service companies. In contrast to private power developers, most ESCOs are relatively small and poorly capitalized. The size and resources of most energy services firms more closely parallels the QF industry at its inception compared to the current private power market. As mentioned earlier, energy service companies are described as an "infant industry." This characterization also appears appropriate in comparison to electric utilities, which are well-established and typically use ratepayer dollars to finance demand-side management programs, often at the request of their regulators. A revealing anecdote characterizing this problem is described in the process evaluation conducted by Lawrence Berkeley Laboratory (LBL) of the Madison Gas and Electric Competition Pilot Program (Vine, et al., 1990). To induce an ESCO to participate in this program, its administrators had to allocate part of their budget as start-up costs for a firm to set-up operation in the community. Although these start-up costs were modest ($50K), the need for this kind of seed money strongly suggests that access to capital for ESCOs is limited. The multi-billion dollar level of capital formation that is being realized by private power producers is a long way off for the ESCO industry. In contrast, the leading ESCOs probably have combined annual revenues of about $100-200 million/year. Moreover, at this stage of their development, the cost of capital for most ESCOs is significantly higher than a utility's cost of capital. This raises the ESCOs' required rate of return.

With respect to upstream/downstream integration, certain major manufacturers of end use equipment (e.g., Honeywell, Johnson Controls) offer a full range of energy management services (complete audit, retrofit specification, financing, O&M) to large customers directly in addition to their more conventional arrangements with distributors and engineering firms. These firms have also begun to submit bids in DSM bidding programs. The need for access to large amounts of capital and desire to minimize risk have also been driving forces in the strategic alliances that have begun to develop in the ESCO industry. For example, several major ESCOs were started by electric utilities as unregulated subsidiaries or affiliates.[7] Recently, other utilities have begun to enter the ESCO business through acquisitions or particular ownership relationships with

[7] Examples of ESCOs and their parent utility (in parentheses) include Puget Energy Services Incorporated (Puget Power), Central Hudson Enterprises (Central Hudson Gas & Electric), EUA Cogenex (Eastern Utilities Associated), and HEC Inc. (Northeast Utilities).

ESCOs.[8] For these independent ESCOs, electric utilities bring tremendous financial resources. Even these alliances will not eliminate capital formation problems for several reasons, First, because of the structure of performance contracting arrangements, the timing of earnings will at a minimum be delayed. Second, the capital allocation mechanisms within firms restrict investment to the best opportunities. As long as ESCOs have limited returns on equity, their access to capital will be constrained.

Other types of strategic alliances involve creation by several firms of a joint venture business entity which submits a bid in response to a utility DSM RFP. One typical combination involves arrangements between a local firm with some ties and knowledge of the utility's service territory and customer base that puts in a proposal with one or two other ESCOs that have managed larger projects as part of a DSM bidding program, and presumably have greater access to capital.

At the current stage of DSM industry development, measured data on the delivered costs per kWh saved over the long-term are not particularly well documented for either ESCOs or utility-DSM programs. There is no a priori reason to believe that ESCOs can deliver energy efficiency at a lower cost than utility-sponsored DSM programs. Alternatively, there is no compelling case for granting utilities a DSM monopoly. We summarize briefly the advantages and disadvantages of utilities and ESCOs as downstream intermediaries in the DSM market. Utilities have significant "incumbent" advantages (e.g., detailed knowledge of their service territory, long-term relationship with customers, and an established customer service infrastructure), lower costs of capital, and a greater ability to capitalize on economies of scale in terms of equipment costs (e.g., bulk purchase of efficiency equipment). Moreover, the utility, if it desires, has significant opportunities for cross-subsidization that can mask its true cost of delivering demand-side programs, because much of its demand forecasting and customer service infrastructure perform other functions in addition to acquisition of demand-side resources. In contrast, some ESCOs have demonstrated an ability to develop specialized expertise and skills in certain technologies or market segments. ESCOs may also have lower administrative or labor costs than a utility, which allows it to deliver DSM more effectively, although ESCOs will typically seek a higher rate of return on investment than a utility. ESCOs that participate in DSM bidding programs have an ongoing incentive to reduce costs and maintain and maximize savings, particularly if the ESCO receives fixed payments from the utility that are tied to verified performance over time. Finally, there are significant differences in performance risk allocation between utility-sponsored DSM programs and ESCOs participating in DSM bidding programs. At present, ratepayers bear the principal risks for DSM savings in programs delivered by utilities, while in DSM delivered by ESCOs, that risk is typically borne by ESCO shareholders and/or by the host customer. In light of the different risks, capabilities, and prospects for utility

[8] Northeast Utilities recently acquired HEC and Pacific Gas & Electric is developing some joint ventures with Sycom.

DSM and ESCO activity, it is useful to examine different ways to mix and balance these activities. This is the goal of the next section.

5.0 Alternative Models for Injecting Competitive Forces in DSM Markets

In this section we examine four different ways in which the benefits of competition can be applied to DSM markets. In each case, there is an important regulatory role, although the extent and locus of regulatory intervention differs among the options. In all cases, the regulator's basic goal of controlling the costs of franchised monopoly utilities is an important concern. In practice, that concern must be balanced against other goals such as promoting non-discriminatory service, innovation and administrative efficiency. We characterize these four options as (1) innovative approaches to integrate downstream (i.e., utilities) with upstream suppliers, (2) competition among energy service providers, (3) competition among the aggregation entities (utility vs. ESCOs), and (4) "yardstick" competition among utilities.

5.1 Innovative Approaches to Integrate Downstream with Upstream Suppliers

One policy option which is receiving increasing attention are efforts by utilities to develop innovative approaches to procuring conservation resources that involve more direct involvement with and/or incentives to upstream suppliers (i.e., manufacturers).[9] This approach focuses on failures of upstream/downstream co-ordination, and promotes interventions in demand-side markets that forge better linkages. The goal is to transcend some of the barriers to innovation for end-use efficiency that were identified in our discussion of appliance manufacturing (see Section 4.1). Several utilities and other parties have formed an adhoc organization called the "Golden Carrot" Consortium in which utilities work with manufacturers to stimulate the market for the next generation of high-efficiency equipment. These linkages will stimulate competition in the end-use product markets, rather than at the level of distribution or delivery vehicles.

Initial work on the "golden carrot" concept has focused principally on refrigerators because these appliances account for a significant portion of residential electricity consumption (1000-2000 Kwh/year, or roughly 10-20% of average annual residential electricity use). In addition, the pending phase out of chlorofluorocarbons (CFCs) means that technological changes will be occurring in the manufacturing process anyway. Finally, proponents claim that the

[9] A number of groups have been active in the Golden Carrot Consortium including Pacific Gas & Electric, Natural Resources Defense Council, American Council for an Energy Efficient Economy, Environmental Protection Agency, Bonneville Power Administration, Washington State Energy Office, and Southern California Edison. Organizations representing appliance manufacturers (e.g., American Home Appliance Manufactures Maytag, Whirlpool, General Electric, and White Consolidated Industries), other utilities, and energy offices have also been sending observers.

technical potential exists for substantial efficiency improvements which could be captured in the near-term.[10] The Golden Carrot Consortium has defined a super-efficient refrigerator as one that conforms with trial Standard Level 5 under the DOE 1993 rulemaking for refrigerators (see Figure 3).[11] These units would be about 28% more efficient than a similar unit built to the 1993 federal NAECA standard. Thus, a typical top-mount 18 cubic foot model would be limited to no more than about 500 kWh/year to meet the minimum qualifications for the program. This compares with the 1993 energy use standard for a typical new refrigerator of about 700 Kwh/year.[12] Possible efficiency options that were examined by DOE's technical analysis include evacuated panels, two-compressor systems, and adaptive defrost, which could lower annual usage to about 500-575 kWh/year.

The Golden Carrot Consortium has proposed that interested utilities make a significant financial commitment to one of two pooled incentive mechanisms (or both). These are: 1) a competitive bid in which manufacturers compete for a winner-take-all pool of money through a request-for-proposals (RFP) process and 2) a coordinated rebate pool which would establish standardized eligibility guidelines for super-efficient utility refrigerator DSM programs in which all manufacturers could compete. The eligibility guidelines for the rebate pool would be set by the winning bid from the competitive bid process. Individual utilities will determine their own contribution levels to the program.[13] Innovative programs such as this have a myriad of implementation issues; many of which are addressed in the draft prospectus (L'Ecuyer, 1991).

The competitive bid procurement represents a significant departure from current utility approaches toward acquiring DSM resources, because a *direct* incentive to manufacturers is provided to design and produce super-efficient refrigerators. It is envisioned that manufacturers would compete in the RFP process based on specified criteria: unit efficiency, delivery date, and requested incentive. The winning manufacturer will be provided with a guaranteed pot of money put up by utilities to offset a portion of the risk of developing and mass-producing a super-efficient refrigerator. A variant of this approach has been tried recently in Sweden by the National Energy Administration (NEA) (Westling, 1990). The NEA pulled together a group of large appliance purchasers (mostly large real estate companies) to develop broad technical

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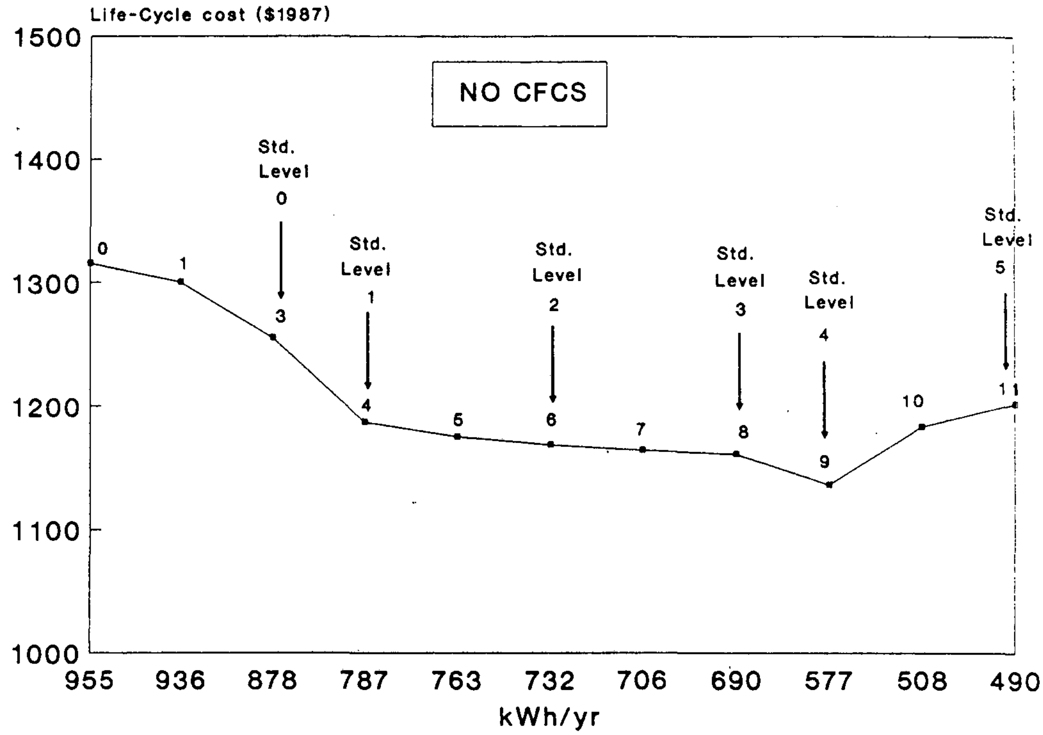
[10] Super-efficient technology options in the R&D phase were analyzed extensively as part of the 1993 National Appliance Energy Conservation Act (NAECA) standards.

[11] Personal communication from M. L'Ecuyer, Environmental Protection Agency entitled, "The Golden Carrot Super-Efficient Refrigerator Program: Replacement and Early Retirement of Refrigerators in the mid-1990's" (draft), May 13, 1991.

[12] The most common refrigerator was a 18 cubic feet, top-mount automatic defrost.

[13] The consortium has suggested one approach to determining appropriate funding levels for individual utilities: commitment of funds that would allow super-efficient refrigerators to capture about 5% of total refrigerator sales in the utility's service territory over the three-year expected life of the program.

Figure 3. Analysis of Refrigerator Efficiency Options for Appliance Standards



specifications (mandatory and desired) for very-efficient refrigerators that would use less than 510 kWh/year for an 18 cubic foot model. The purchasing group represented about 25% of the Swedish refrigeratory/freezer market, estimated at about 170,000 units/year, mostly in multifamily dwellings. NEA then allocated about $350,000 for the program, which included rebates to purchasers and incentives for suppliers.[14] The NEA sponsored a procurement in which manufacturers were invited to submit proposals that addressed mandatory and desired attributes, would receive cash rewards if electricity usage was significantly lower than the mandatory requirement, and were guaranteed an order of at least 500 units (Westling 1990). Each purchaser (i.e., real estate company) also receives a rebate subsidy of about $180/unit. Three companies responded and submitted designs and the NEA selected Electrolux as the winner, which will produce two different types of units (Swedish DOEE, 1991).[15] The Golden

[14] NEA set aside 2 million SEK (Swedish kroners).

[15] Electrolux expects to make deliveries by September 1991. The winning designs reduce energy use by using extra insulation and a smaller, more efficient compressor, a maximized heat radiation surface and vacuum insulation panels.

Carrot Consortium is trying to get U.S. (and Canadian) utilities to commit about $20-45 million to the program, which is believed to be about the amount needed to generate serious interest among larger manufacturers (Golden Carrot Executive Committee, 1991).[16]

Compared to conventional utility refrigerator rebate programs, this type of incentive mechanism moves much farther upstream and into the future in an attempt to change the efficiency mix of refrigerators produced. The approach is attractive because it potentially reduces transaction costs. It is easier to work directly with a handful of major manufacturers compared to thousands of appliance dealers/sales persons and millions of ultimate customers. Moreover, utilities can be more confident that their incremental investments are pulling the market toward higher efficiency products that otherwise may not have been produced. Finally, direct incentives to manufacturers might ultimately allow utilities to influence the market more effectively and at a much lower cost compared to the utility's cost of implementing conventional refrigerator rebate programs (its administrative costs plus rebates paid to either customers or dealers).

A secondary element of the "golden carrot" proposal is the development of a common set of eligibility guidelines for super-efficient refrigerator programs offered by utilities. Establishment of a coordinated rebate pool for super-efficient refrigerators builds upon current utility DSM program experience. Many utilities currently operate DSM programs that attempt to get customers to purchase high efficiency refrigerators. Typically, eligibility guidelines for current refrigerator rebate programs are set to exceed existing state or federal appliance standards by a specified percentage and tend to change over time. For example, Table 2 summarizes changes in Pacific Gas & Electric's high-efficiency refrigerator program over the last decade. Not surprisingly, program designs and eligibility guidelines for efficiency and rebate levels vary significantly among utilities. Some utilities offer rebates to customers, while others provide incentives to dealers and the sales force for selling efficient refrigerators. In part, this reflects varying opinions about who really influences the replacement market for refrigerator purchases: customers, dealers, or the sales force (Mataloni and Devito 1991). From the perspective of the appliance manufacturer that serves a national market, it is quite difficult to respond to these varying programs in regional markets served by utilities.that serves a national market, it is quite difficult to respond to these varying program designs in regional markets served by utilities.

[16] The U.S. program would be substantially bigger in scale than the Swedish program with regard to the number of high-efficiency refrigerators produced. The larger scale accounts for the greater financial requirements.

Table 2. PG&E Refrigerator Rebate Program

Year	Rebate Level $	Eligibility Guidelines
1979	*California Appliance Standards*	
1982	$50	10%
1983	$50 $100	20% 35%
1984	$50	20%
1985	$50 $75	20-35% 35%
1987	*California Standards Revised*	
	$50 $75	10% 15%
1988	$50 $75	10% 15%
1989	$50 $75	10% 15%
1990	*Federal Standards Enacted*	
	$50 $100	10% 15%
1991	$50 $75 $150	10% 15% 20%

Notes: Eligibility guideline refers to minimum energy efficiency level that must be achieved for a qualifying rebate which exceeds the applicable state or federal appliance efficiency standard.

A coordinated rebate pool would provide manufacturers with a consistent signal regarding utility incentives available to customers for the purchase of super-efficient refrigerators. This type of advanced planning also may help overcome one of the barriers that has developed for other high-efficiency products such as compact fluorescents and electronic ballasts, namely limited product availability due to constraints on manufacturer production capacity. Given the diversity in the utility industry, this degree of coordination may prove to be quite a challenge, although a number of utilities have expressed interest in and some enthusiasm for the concept. Based on the experience of California utilities, there is strong anecdotal evidence to suggest that manufacturers respond and adjust their relative product mix in response to utility rebate programs if the market is viewed as sufficiently large.[17]

In summary, this approach envisions a consortium of utilities sharing information with upstream manufacturers and subsidizing them to cooperate in future large-scale DSM programs. Utilities hope that manufacturers will perceive the market to be sufficiently large and profitable to stimulate development and production of super-efficient models that significantly exceed existing standards. The basic concept of incentives to manufacturers for advanced technology might also be applicable to other end-use efficiency technologies. However, analysis is needed to determine which technical opportunities are best suited to manufacturer incentives compared to financial incentives offered by utilities that are directed at consumers.

Despite its appeal, this type of incentive approach is untested in the U.S. and raises difficult public policy issues that need to be addressed. Utilities and their regulators will need to be convinced that utility incentive dollars add to private industry investments rather than displace R&D planned by manufacturers. Society at large is the principal beneficiary of a "Golden Carrot" program but regulators also will want assurance that utility expenditures are cost-justified for customers in their own service territory. Utilities will most likely be interested in this program only if regulators agree that it is an appropriate risk to be taken by ratepayers. However, some regulators may be uncomfortable with the use of ratepayer dollars to fund this type of DSM program. PUCs authorize utility expenditures for R&D efforts as well as DSM programs, which typically involve only proven technologies that are commercially available. "Golden Carrot" approaches involve commercialization and acceleration of efficient technologies under development, and thus falls in between these two categories. One possible solution is for utility shareholders to be rewarded financially for subsequent improvements in appliance efficiency attributable to the Golden Carrot Program, possibly by treating program expenditures as an investment for which the utility is allowed to earn a return. Finally, there are also a host of program design and practical implementation issues to resolve. For example, proponents must

[17] There have been comparisons of product shipments to California and other regional markets during periods in which utility rebate programs for high-efficiency refrigerators were in effect (typically June-September) which show that high-efficiency models that qualify for rebates account for a significant share of the California market, but much smaller shares in other regions.

develop mechanisms to guarantee that super-efficient refrigerators are delivered to local distributors in the service territory of contributing utilities and purchased by that utility's customers. Many of these issues arise because of the existing market structure as well as the number of intermediaries that exist in demand-side markets.

5.2 Competition Among Energy Service Providers

Since the inception of utility DSM activities in the late 1970s, utilities have traditionally contracted out some program elements to private sector firms. For example, in-house utility staff were typically responsible for program design, marketing support, and monitoring and verification of installations. Customer information programs were often delivered by firms that specialized in training energy auditors and were chosen by the utility on the basis of qualifications and service cost. Utility residential weatherization program managers often selected a list of contractors that were eligible to install pre-specified measures in customer homes.

Figure 4 represents schematically a continuum of alternative delivery mechanisms that utilities are currently utilizing in their DSM programs (EPRI, 1991). Expanded use of competitive processes by utilities to contract for *energy services* represents a "middle" approach among the spectrum of DSM procurement methods. For example, a utility may issue a Request for Proposal (RFP) which solicits bids from competing firms for the right to deliver various services for a particular DSM program – a commercial/industrial direct installation program. The utility may hire separate contractors to conduct aspects of the program on a time and materials basis: a firm that specializes in building energy audits, firms that install efficient HVAC and/or lighting equipment, and an engineering firm for quality assurance. Alternatively, the utility may want to hire a firm that can manage and deliver all services required by the program for a turnkey fixed price. Firms are selected competitively based on qualifications, experience, and price. If the utility hires one firm to deliver the entire program, the utility may also negotiate some type of performance incentive with the contractor, which is linked to achievement of program goals, in addition to the firm's bid for the respective services. In both situations, the utility uses conventional competitive procurement processes to buy energy services from private sector firms that supplement and complement existing utility DSM staff activities.

For utilities with rapidly growing DSM programs, expanding the use of services provided by third-party firms to encompass additional aspects of DSM program delivery is attractive. Many utilities are reluctant to undertake major additions to their own staff (Taylor 1990). Moreover, the current generation of DSM programs often requires specialized technical and management skills: design assistance in new construction, audits of complex facilities or industrial processes, and project and construction management. Thus, we expect that utilities will experiment with innovative approaches that rely on the existing energy services infrastructure (e.g., trade allies, builders, architect and engineering firms, and vendors of specific projects) to implement DSM programs developed by the utility. Moreover, it will probably be necessary for regulators to become more involved in reviewing utility practices in procuring energy services. Likely areas of expansion include auditing and control over costs and issues related to assuring fair competition (e.g., reviewing complaints from injured parties). It may be that most utilities will prefer this approach because they can maintain more control over program implementation, and effectively limit the nature and extent of contacts between customers and third party firms, who utilities may ultimately perceive as potential competitors.

Figure 4. Alternative Delivery Mechanisms for Utility DSM Programs

Utility Provided ←	Who Provides Services	→ Third-Party Provided
In-House Utility DSM Program	3rd Party Role in Utility DSM program	Performance Contracting
	• Turn-key Time & Materials	DSM Bidding
	• Fixed Price Utility-specified Turnkey DSM Program	• Franchised Solicitations • "Open" Solicitations

Adapted from EPRI, "Utility Demand-Side Competitive Procurements Methods," 1991.

As Figure 4 illustrates, demand-side bidding represents one end of the spectrum and can be viewed in one sense as an attempt to stretch the boundaries of procurement of energy services to the provision of saved energy. As discussed in section 4.2, in demand-side bidding programs, the utility relies on the market response of third-party energy service companies that are willing to sign long-term contracts to produce specified amounts of saved energy. Winning bidders are contractually responsible for undertaking the major steps in acquiring and maintaining DSM resources, while the utility's role is reduced as compared to other approaches.[18] The utility may design its bidding program so that energy service companies are

[18] The utility specifies only the overall resource need, a ceiling price (possibly), and eligibility/threshold requirements.

competing to gain privileged access to "mine" a pre-defined franchise for its energy savings (e.g., large C/I customers over 500 kW in region X) or the bidding program may be an "open" solicitation encompassing all eligible market segments (e.g., existing residential and commercial buildings). In DSM bidding programs, the obvious competition occurs among energy service companies. However based on current experience, it is clear that ESCOs are also competing in a less explicit fashion against other utility-sponsored DSM programs. This issue will be discussed in more detail in the next section.

5.3 Competition Among the Aggregation Entities: Utilities vs. ESCOs

The desirability of competitive alternatives to utility DSM programs is one of the rationales used by PUCs that have ordered utilities to establish DSM bidding programs. Currently, demand-side resources that are to be acquired through a utility's DSM programs are determined primarily through an administrative process in virtually all states. A typical situation is that a utility will assess technical and market potential of DSM options in its planning process and assess the cost-effectiveness of various programs. The company will then seek to gain approval and cost-recovery for its efforts either through a regulatory proceeding (e.g., rate case) or negotiated settlement with other interested parties. The regulator may not be in a particularly good position to question the utility's own estimate of the costs of these programs, except to the extent that other parties raise issues regarding the utility's design or implementation of its programs. Thus, PUCs often look for assurance and seek mechanisms that can demonstrate that a utility's DSM programs are being implemented in the most cost-effective manner. Some regulators view competition between utilities and ESCOs as providing a market test that will provide a benchmark which can be used to help assess utility DSM performance in terms of program cost, cost-effectiveness, and development of DSM market potential. These competitions between utilities and ESCOs can either be explicit or implicit depending on program design.

The Wisconsin Public Service Commission's order to Madison Gas & Electric (MGE) to conduct an Energy Conservation Competition pilot ("the Competition") in June 1988 is the best example of an *explicit* competition between utilities and ESCOs (Vine et al. 1990). It is probably most useful to view the Competition as a contest between the utility and third-party energy service providers. In this pilot, MGE offered conservation programs of its own design to three targeted customer sectors: small commercial and industrial (C&I) customers, large C&I customers, and the residential rental sector. Simultaneously, three energy service companies were selected through a competitive bidding process, one of which would serve each of these three sectors. MG&E and one ESCO competed to provide DSM services in each sector given a fixed budget.[19] The competitor that achieved the most cost-effective energy conservation

[19] MG&E received a total of $950,000 for one year and the combined budget of the three ESCOs was $950,000.

(based on a scoring system) in each sector was to receive a cash incentive.[20] The cash bonus ranged from 10% to 30% of the funds spent by the winning competitor in each sector. The PUC was quite explicit in its attempt to create a competitive environment as evidenced by its objectives:

- "motivate MGE to improve its conservation efforts in terms of both the quantity and cost-effectiveness of conservation achieved

- test how cost-effectively conservation services can be delivered through various marketing services, strategies, and providers."

The Competition was ordered principally because the PSC was dissatisfied with the pace at which MGE was developing its conservation efforts and wanted to signal its concern to top management in a visible way. Vine et al. (1990) concluded that the pilot was generally successful in the short-term in stimulating utility and third party delivery of energy services. The Competition was viewed as a "negative stick" by other Wisconsin utilities, who in some cases were willing to accelerate their DSM programs to avoid this type of pilot program. However, the Competition approach as tested in Wisconsin had drawbacks which severely limit its transferability to other states. Both PSC and MGE staff noted that the Competition had no long-term effect on MGE management's commitment to DSM programs. Moreover, some energy service providers are reluctant to compete against utilities in these types of programs because they have concluded that the long-term negatives (e.g., disruption of existing business relationships) outweigh short-term benefits. Finally, structured competitions between utilities and ESCOs often will require PUC staff to assume a very proactive stance and undertake more direct and sustained involvement in the implementation details of DSM programs. Thus, ironically, unleashing market forces in head-to-head competitions does not necessarily make the regulator's job any easier.

The extent to which there is overt competition between utilities and ESCOs varies among DSM bidding programs currently being implemented by utilities. The degree of direct competition between utility-sponsored DSM programs and DSM bidding programs depends on the comprehensiveness of the utility's existing DSM programs and to a lesser extent, the origins and driving force behind the bidding program. Typically, competition is *implicit* in the sense that ESCOs submitting bids in DSM bidding programs must always be aware of the scope and structure of existing utility-sponsored DSM programs, because they limit the size of the market that the ESCO can reach. In cases where the utility implements a DSM bidding program voluntarily on its own initiative, the utility will typically go to greater lengths to define a cooperative partnership arrangement with ESCOs, including some attempt to ensure that there

[20] The Competition was overseen by a three member Panel comprised of one representative from the utility, PUC, and an independent third-party and was responsible for determining policy guidelines, resolution of disputes, and tracking of results.

is minimal overlap between market segments served by various DSM program options.[21] On the other hand, in states such as Massachusetts, New York, and New Jersey, utilities have been ordered to conduct "all-source" (both supply and demand) and simultaneously offer utility-sponsored DSM programs that are comprehensive (i.e., target all customer classes and end uses). Inevitably, situations arise in which there is competition between the utility-sponsored DSM program and the ESCOs bid.

Coordinating the side-by-side operation of utility-sponsored programs and DSM bidding programs is a formidable challenge even for utilities that are enthusiastic about DSM bidding, let alone utilities that are skeptical. Delivering and targeting conservation services to the same customers creates potential problems for both utilities and ESCOs. Utilities are concerned that a wide array of program choices are confusing to customers. They also want to be assured that they are paying for savings attributable to measures installed by the ESCO in the bidding program but not to reduced usage that occurs because of participation in a utility-sponsored DSM program. ESCOs are concerned that they are competing against a moving target. Utilities can effectively undercut their market opportunities by increasing financial incentives offered in utility-sponsored rebate programs which make it more difficult for the ESCO to achieve its contractually specified demand or energy savings reductions. ESCOs are also concerned about the potential abuses that arise because of the utility's "conflict of interest". If so inclined, utility field and customer service representatives have numerous opportunities to raise additional obstacles for ESCOs, including delays in approving contracts, negative responses to customer inquiries regarding ESCOs, which could work in favor of company-initiated DSM programs. For those inclined toward supply-side analogies, Qualified Facilities have legal protections under PURPA that offer countervailing pressures against potentially hostile utilities. In the current situation, ESCOs participating in DSM bidding programs have no legal protections on their rights to compete fully.

The relationship between utility-sponsored DSM programs and DSM bidding that target similar customer classes and market segments critically affects the future prospects for DSM bidding. It also illustrates some of the fundamental differences between competitive procurements for supply-side and demand-side resources. In evaluating supply-side bids, the utility must account for the fact that individual bids affect the value of other supply-side bids to the utility. In contrast, in DSM bidding, individual DSM bids as well as utility-sponsored DSM programs affect the available market potential that can be captured over a defined time period. The utility can create problems for itself and ESCOs by awarding too many "mining" rights to a finite resource. If both the utility and the ESCO are trying to solicit the same customers, it can create a situation similar to "over-fishing" or "over-harvesting," whereby effort is duplicated unproductively and the efficient yield is less. Therefore, implicit competition between ESCOs and utility DSM programs is typically inefficient and counter-productive.

[21] Examples include Public Service Indiana and Public Service Company of Colorado.

5.4 "Yardstick" Competition Among Utilities

During the last decade, a number of Commissions have invoked the notion of "yardstick" competition among utilities in evaluating their DSM efforts. In contrast to the other three approaches which either involve interventions in end user markets or use of market-oriented mechanisms, this option is a tool used exclusively by regulators. Initially, PUCs required utilities to file integrated resource and/or long-term DSM plans that described the utility's approach to meeting its future resource needs. In evaluating these plans, some Commissions would then compare the utility's demand-side management plan relative to the efforts of other similar utilities (hopefully), often using fairly crude quantitative and qualitative indicators. Initially, Commissions tended to focus on the level of DSM expenditures, the magnitude of expected capacity and energy savings, and customer participation rates for various DSM programs (Nadel 1991). The shortcomings of some of these indicators are fairly obvious. For example, focusing on utility dollars spent on DSM tends to encourage gold-plating and does not reward actual performance. More recently, Commissions have paid attention to such indicators as the relative mix of DSM programs across customer classes, end uses, and by load shape objective (e.g., load management, end-use efficiency, or load-retention/load-building), the fraction of future load growth to be met by DSM programs, and the overall economic benefits of DSM programs from perspectives of the utility ratepayer, non-participant and society.

The importance of "yardstick" comparisons has surfaced most recently in the context of incentive ratemaking for utility DSM.[22] Incentive mechanisms are under consideration in at least 21 states (Reid and Chamberlain 1990). These ratemaking reforms focus on removing existing disincentives to utility investment in DSM and, in most cases, provide additional financial incentives to utility shareholders for exemplary DSM performance. In designing bonus-type incentive mechanisms, Commissions must confront head-on the issue of the criteria that will be used to assess and reward utility DSM performance. Conceptually, some Commissions have tried to link the utility's ability to make additional earnings on its DSM programs on the utility's ability to demonstrate that its DSM efforts are exemplary. Typically, Commissions define exemplary performance relative to some "yardstick," such as current practice or level of effort of other utilities in the state or region.

The Wisconsin PSC has been particularly interested in "yardstick" competition among utilities and has recently been experimenting with more sophisticated approaches. For example, the Commission has attempted to set quantitative and qualitative DSM goals and expectations for individual utilities in their most recent rate cases. Quantitative goals are established in terms of net benefits, which are determined by the net reduction in utility revenue requirements as a

[22] The increasing popularity of "carrots" (i.e., incentives to utility shareholders and managers) offered by regulators to those utilities that aggressively develop demand-side efforts provides additional evidence that many PUCs are expecting utilities to be the key institution that will develop DSM resources.

result of utility DSM programs.[23] Net benefits for individual utilities are set by sector (residential, farm, commercial/industrial) and are established by translating the performance achievements of comparable utilities with the most aggressive programs after adjustments are made to account for size differences and unique conditions or circumstances. Initially, the Commission used the results from the Madison Gas Electric Competition Pilot, specifically net benefits achieved by MGE and its ESCO competitors over the specified one-year time period, to define satisfactory levels of performance for some other utilities in the state. The PSC believes that the net benefits approach allows utility management more flexibility in terms of achieving delivery of cost-effective DSM programs. Qualitative goals are also still considered by the Commission including customer satisfaction, breadth of DSM measures, programs and delivery mechanisms offered in each sector, adequacy of program evaluation, and depth of conservation (Newman, 1991). In practice, the value of and ease with which various "yardstick" indicators can be developed depends to some extent on circumstance. For example, the Wisconsin PSC regulates ten small and medium-sized utilities; its situation is quite conducive to direct comparisons among utilities. Other commissions might regulate only one or two utilities of very different sizes and thus would have to draw on utilities from outside the state to make comparisons. This makes collection of necessary data somewhat problematic at the present time, but as more standardized DSM results become available, this option might become more viable. To summarize, the use of "yardstick" competition by regulators to compare utility DSM performance, while imperfect, is an area in which we expect regulators will continue to experiment with given their perception of the substantial market barriers that exist in the overall demand-side market.

6.0 Conclusion

Competitive forces on the supply-side are developing and contributing to significant gains in efficiency. On the demand-side, the locus of decision-making for DSM of all kinds is largely determined in an administrative fashion and represents the joint consensus of regulators, utilities, and other interested parties. Demand-side resource options are inherently diverse, diffuse, and decentralized, in part because of the myriad market barriers that give rise to these efficiency opportunities. This diversity also leads us to conclude that it is highly unlikely that one type of competitive mechanism, such as bidding, will ultimately emerge as dominant. Rather, there are a variety of innovative and competitive mechanisms which deserve consideration and are likely to be promising in terms of improving the functioning of demand-side markets.

The alternative models for injecting competitive forces into DSM differ with respect to their underlying vision of the role of the utility in the demand-side arena. Approaches that involve "yardstick" competition among utilities, emphasis on increased competition among

[23] Net benefits are defined as the difference between program benefits (which include value of avoided capacity savings, T&D, and lifetime energy savings and externalities) and program costs incurred by the utility.

energy service providers for services defined by the utility buyer, and increased utility involvement with upstream suppliers tend to rely more heavily on the utility as the central agent in defining DSM resource opportunities. In contrast, in DSM bidding programs, third party firms that are relatively independent of utility control or guidance will have a greater role in defining DSM resources and in providing comprehensive energy services.

The state utility regulator is ultimately faced with the responsibility for choosing what the emphasis of DSM activities will be in a particular region. Granting utilities an effective monopoly over DSM may potentially broaden delivery of programs, but raises issues of cost control. Competition can provide a check on utility costs, but it is not always feasible or effective. ESCOs are a limited substitute for utility DSM. Bidding by ESCOs for energy savings will provide some alternative measure of DSM costs, but many incommensurables, such as performance requirements, must be taken into account to make such comparisons. The model of regulation required to deal with the issues raised by integrated resource planning is active, because market forces, particularly on the demand side, are still weak.

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Appendix A

The Appliance Manufacturing Market

The appliance manufacturing market discussed in Section 4.2 above is treated formally here. We rely primarily on the analysis of Stoft, Chan and Hobart (1990). They begin from the empirical observation that concentration in this market is high; the top four firms, for example, have about 95% of the market for refrigerators and freezers. While this degree of market concentration can be conducive to technological innovation, it may happen that innovation proceeds, but **seller** market power limits the benefits to producer profits, and **also does not lead to** consumer cost reductions (Stoneman, 1987).

There is a countervailing force, however, in the appliance manufacturing and distribution market, namely heavy concentration at the intermediate demand level due to the presence of large retailers (AHAM, 1989). One reflection of this buyer power is that standard economic theories of supplier oligopoly do not appear to be substantiated empirically. In the Cournot oligopoly model, a high degree of supplier concentration is reflected in large price mark-ups above marginal cost. Mark-ups that are observed in the appliance manufacturing market are considerably lower than what empirical concentration ratios and the Cournot theory would predict.

We describe these relationships in some detail, because it also illustrates an important mechanism through which innovation in energy efficiency tends to be suppressed. In the Cournot theory (Waterson, 1987), the profit-maximizing oligopoly firm sets its price P at a mark-up μ over marginal cost c, where μ depends on the firm's price elasticity of demand ν_f, i.e.

$$P = \mu * c, \text{ where } \mu = \nu_f /(1 - \nu_f). \tag{1}$$

This behavior is tied to the structure of the industry through the linkage between the number of firms NF and the price elasticity of the industry as a whole ν_i as follows

$$\nu_f = NF * \nu_i . \tag{2}$$

By substituting and rearranging terms from Equations (1) and (2) we know that:

$$NF = \mu/(\nu_i\ (1-\mu)). \qquad (3)$$

Stoft, Chan and Hobart show that Eq. (3) is not consistent with observed data on the refrigerator manufacturing industry, where $\mu = 1.12$, $\nu_i = -0.33$, and NF = 4. Their solution to this inconsistency is to assume that the buyer market power of the large retailers is what lowers mark-ups from the theoretical level. Thus they calculate an "effective" number of firms in the industry, which is much higher than the observed number.

The importance of these observations is that buyer market power raises the firm's elasticity and therefore lowers profits (i.e., mark-up). Stoft, Chan and Hobart then go on to show that similar effects can result from improved energy efficiency. The key assumption in this next argument is that appliance demand has constant "life-cycle cost" elasticity. Life-cycle cost includes both original purchase price and operating cost. We can write the demand for appliances in terms of life-cycle cost as follows:

$$Q = a(P + (1/r)\ F)^b \qquad (4)$$

where Q	=	quantity demanded,
P	=	purchase price,
r	=	consumer discount rate,
F	=	annual operating cost,
a,b	=	parameters

In Eq. (4) life-cycle cost is $(P + (1/r)F)$. This expression uses the infinite horizon approximation to lifecycle variable cost. This approximation is convenient and valid for the range of lifetimes and discount rates that concern us. Examining Eq. (4) we can see that any efficiency improvement will shift the elasticity away from the operating cost term to the purchase price term. We can use the specification in Eq. (4) to derive the industry price elasticity ν_i, namely:

$$\nu_i = b*P/(P + (1/r)F). \tag{5}$$

From Eq. (5) we see that price elasticity increases as purchase price goes up and as F goes down. Thus, the imposition of appliance standards will lower manufacturer's mark-ups because the manufacturer incurs additional costs in order to reduce energy use. The empirical specification of the manufacturer's impact model for the case of refrigerator standards does show this effect, although the magnitude is generally modest.

Eq. (5) is relevant to the entire spectrum of energy efficiency opportunities and makes some general predictions about them. The magnitude of the oligopoly innovation deterrence effect depends critically on the split in life-cycle cost between capital and operating cost. Section 4.2 gives some examples of how this works in practice.